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A MOTH SHEET

FOR ATTRACTING AND RETAINING LIVE SPECIMENS WITHOUT THE USE OF A TRAP OR TENT-ENCLOSURE.

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FOR MANY COLLECTORS who have no need or desire to trap and kill the vast numbers of insects coming to their insect-attracting lights, the type of device described below is very much worth the trouble to construct. It is — in any event — useful, as it effectively increases the power of the sheet-and-light combination to draw in, and "hold", nocturnal flying insects. It is of particular value to entomologists who are interested in capturing live females, for purposes of obtaining eggs for rearing and life history investigation. This "PARABOLIC MOTH-SHEET" was in constant use, along with several "conventional" set-ups (flat sheets with lights hanging in front of them) for a continuos period of 20 months in a single locality (McDonald Forest, 5 miles west of Corvallis, Benton County, Oregon; October 1961 to June 1963). I constructed it at the suggestion of Mr. Gerald Benedetti, then a graduate student in Mechanical Engineering at Oregon State University.

The effect of directing a correctly-located light at a vertical sheet, which is *held in the shape of a parabolic curve,* is such that the whole reflecting-surface (i.e., the whole sheet) appears to be the source of the light.. This results in a very different situation from that observed in the usual (flat) sheet-and-light combination, where there is a circle of fairly intense light at the middle of the sheet only. When the sheet is bent in the form of a parabolic curve, the whole sheet appears to "come alive" with the brilliance of the light it is reflecting, provided that the light is placed at the correct distance from the (inside) vertex of the curve. The distance of the light from the vertex is determined by the shape of the parabolic curve in use; see Fig. 1 (A-D) and photographs.

The size of the sheet (or canvas) used during the trial-period in western Oregon was 16 feet x 7 feet, and it was in operation at ground level, being held in position by 13 vertical poles run-

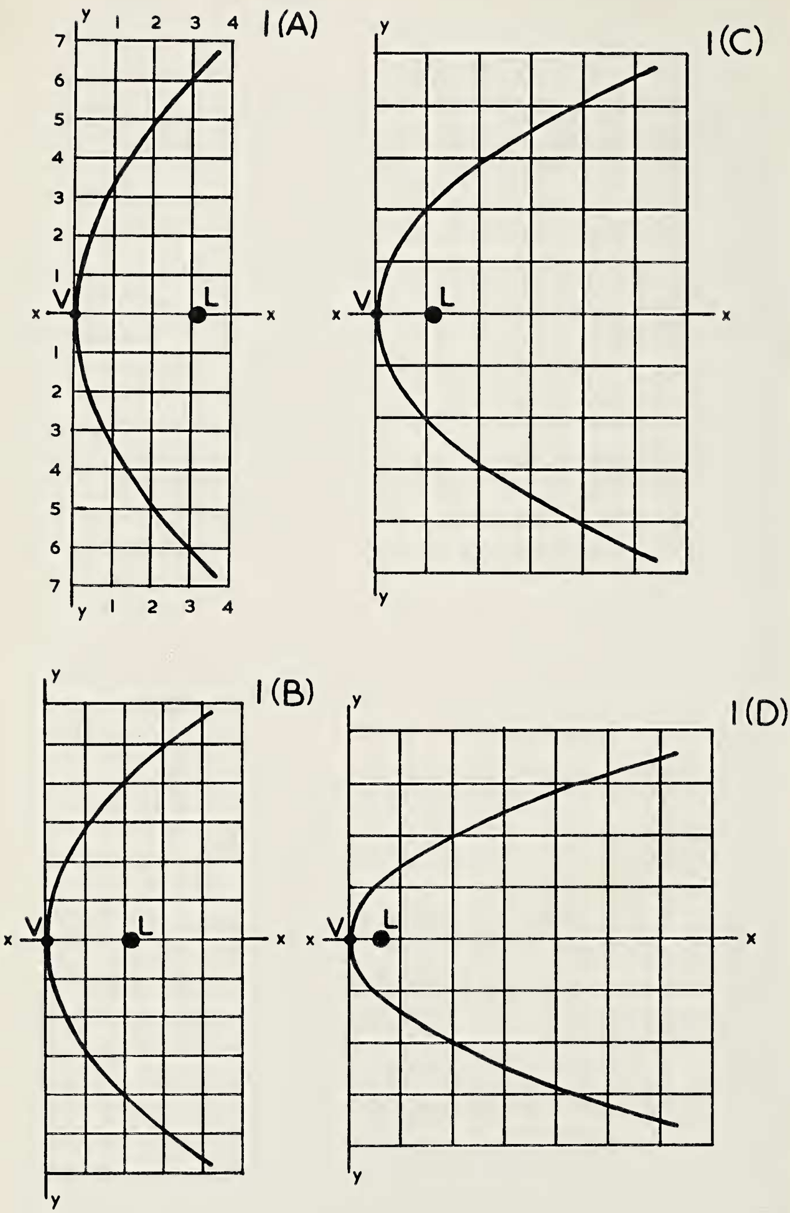

Fig. 1 (A-D) —Diagrams of four possible curves for the Parabolic Moth Sheet. Light source at (L), on a vertical pole. Vertex of curve at (V). Squares are one foot square. Sheet is 16 feet long, shown as if viewed from directly above .

ning through sleeves which were sewn to the canvas; the poles were in turn inserted into short ground-stakes (see Fig. 2) which were easily hammered into the ground. The placement of these ground-staks determined the accuracy of the resulting parabolic curve made by the canvas. Guy wires from the tops of the poles secured the whole structure in the event of high winds. Two 18-inch, 15-watt black light tubes (G.E. F15T8/BL) were hung vertically on the light-pole, one facing directly at the inside vertex of the curve, and the other facing in the opposite direction. (The addition of this second, outward-directed light did not seem to affect the results greatly, although it may have increased the "attracting-power" of the device). The general appearance of the whole set-up can be seen in the photographs, which are of the original parabolic sheet used in Western Oregon.

There are various ways and materials for constructing such an apparatus, either with the intention of making it portable (as described above), or heavier and permanent in one location. The important points are to maintain the parabolic curve with reasonable accuracy, so that the entire sheet appears to be throwing out the light, and not to make the sheet too small. The more surface area for incoming moths to land upon, the better. The 16 foot x 7 foot canvas operated in Oregon did a very impressive job. Of six black light and sheet set-ups in use in the one locality, the parabolic (curved) sheet invariably drew in, and retained, far more insects than any of the others; usually it had a greater catch than the totals of the other five combined.

Moths coming to the parabolic sheet have a greater tendency to remain and settle there. They often bounce back and forth within the curving enclosure before finally settling, but there is not much loss from individuals simply flying off around either end, or over the top, and not returning. (This is one of the disadvantages of a conventional flat sheet operating without any sort of trapping device). Some of the moths will fly around to the unlighted back of the sheet (the outside of the curve) and settle there; it is highly desirable to leave the back unlighted to accommodate such moths, as these are the individuals that would sometimes settle in nearby vegetation after once flying to the light; such species — this is sometimes a behavioral difference between species — are usually missed or overlooked at conventional flat sheets. When this occurs it often pays to shake or lightly beat nearby vegetation, which will cause many of the moths to fly back to the sheet, unless it

Fig. 2

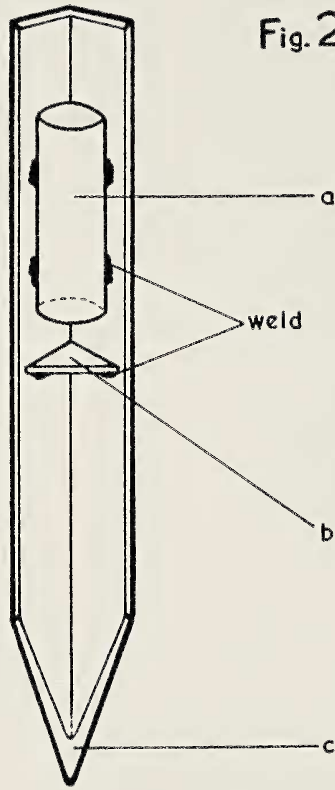

Fig. 2 — Diagram of a Ground Stake, which is easily pounded into the ground to receive the poles that will form the parabolic curve of the sheet. Made of 1½-inch angle iron. Total length about 21 inches. a = 6-inch metal tube, welded into angle iron 3 inches below the top; this tubing is a fraction larger than the diameter of the pole it is to receive; b = a small triangular plate of iron, welded about one inch below the bottom of the tubing, to stop the pole at a specified height after it is inserted through the tubing; c = tapered point on angle iron makes it easier to drive into hard ground.

is cold, in which case most of them will just drop to the ground.

There are many different parabolic curves that could be tried, and some may prove to be more efficient than others in "holding" the moths on the sheet; perhaps also in drawing them to the sheet in the first place. Four possible curves to try are suggested in Fig. 1 (A-D). All comments in this paper are based on experiences with only one of those parabolic curves (Fig. 1A), the shape of which is determined by the light source being set at three feet from the inside vertex of the curve. The light faces directly toward the inside vertex of the curve, as it hangs on a vertical pole which is set at the specified distance out from the inside vertex of the curve. In my experiments, using the curve shown in Fig. 1A, two lights were in operation – one facing the vertex, and the other on the opposite side of the light-pole, facing directly away from the vertex. Other placements of the light (or of several lights) on the pole could be tried, and these might give varying results.

For spacing all the poles correctly on the ground, the easiest method is to stake out 2 strings at right angles to each other, along the ground, one representing the x-x axis (8 feet long is sufficient), and one representing the y-y axis (16 feet long is sufficient). Measurements are made by going out from the vertex, on the x-x axis, and then going either up or down parallel to the y-y axis, to the correct measured distance, for placement of each pair of corresponding opposite poles. (The only single pole, not having an opposite, is the one at the vertex). The sheet should be stretched tightly, so that the end result presents a smooth, wrinkle-free, evenly-curving reflective surface. A soiled, "off-white" canvas or sheet is preferable to a pure white one, for purposes of getting the moths to settle on the sheet with a minimum of flying about. A ground-sheet ("apron") is very desirable along the bottom of the curve. This can be made in 4 four-foot sections, which are easily snapped on along the bottom of the curve after it is set up. (If it is all in one piece, there are too many wrinkles in a 16-foot curving piece). An advantage in having the apron detachable is that it may be removed and washed from time to time, without the inconvenience of taking down the whole structure. After one wet season on muddy ground, the apron becomes the color of the soil, in which case it is rendered practically useless until it is washed. To be of much value, the apron should extend out onto the ground, from the base of the curve, for at least 18 inches all the way around. It is not needed on the back (outside) of the curve.

If a few pieces of curved bark (as available) are placed on the ground around the sheet, it will be found that certain moths (often of the same species) will hide under these, rather than disappearing into nearby weeds or ground litter; in this category are certain noctuids such as some *Agrotis, Euxoa,* and *Ufeus* spp., among others. Quite a few moths will settle on the guy wires, especially (for some unexplained reason) on cold nights; thus the guy wires should be rope or cord, not a smooth-surfaced

material. These and other refinements can be included to suit the intentions of the collector.

To experiment with other parabolic curves for the sheet (i.e., where the light is at some distance from the vertex other than the examples illustrated by Fig. 1.) the following general equation, for determining any points on a proposed parabolic curve, can be used: $y^2 = 4\ AP$. We are solving for P, which is a point on the proposed parabolic curve, when y is a known distance up or down the y-y axis from its intersection (V) with the x-x axis, and A is a KNOWN distance of the light source (L) from the vertex (V), along the x-x axis. This is plotted on graph paper. Lay out the y-y axis and the x-x axis on the graph. When the curve is drawn in, it is to be symmetrical about the V-x axis, with its vertex touching V.

An example follows, to show the steps in finding a point on the proposed curve, when y is set (for example) at 6 feet up or down from the vertex, along the y-y axis, and the distance (A) of light source to vertex is set at 3 feet:

$$y^2 = 4\ AP \text{ (solving for P)}$$
$$12\ P = 36$$
$$P = 3 \text{ feet}$$

In other words, a point on the proposed curve, either 6 feet above or below the x-x axis, is located 3 feet to the right of the y-y axis.

Repeat similar calculations again for several other points on the same proposed curve, setting y at, say, 1, 2, 3, 4, 5, and 8 feet, and keeping the distance (A) of light source to vertex the same in each calculation. Place appropriate dots on the graph after each calculation; when finished, the series of dots may then be connected, resulting in the desired parabolic curve. Using graph paper divided into ½-inch or ¼-inch squares, it is only necessary to solve for about 6 or 7 points on a curve that is to be in the vicinity of 16 feet long. This will give a curve sufficiently accurate to produce the results described above. Anything more precise is not practical to attempt setting up (or to maintain) under field conditions.

ACKNOWLEDGMENTS

I am indebted to Mr. Gerald Benedetti of Livermore, California, for the original suggestion of trying a parabolic curve, and for plotting the curve that was used; to Mr. Lloyd M. Martin of the Los Angeles County Museum, California, for many helpful suggestions on the construction of various types of portable collecting sheets, frames, and ground stakes.

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COVER PHOTO

Daritis ? *howardi* Hy. Edw.

(PERICOPIDAE)

Penultimate instar, filled-out, resting on *Eupatorium* stem. (Length: 80 mm. when filled-out in final instar).

Collected at approx. 7200 ft. elev., on the W. slope of Cabezon Peak, Sandoval Co., NEW MEXICO; 11 OCT. 1958 (half grown); S. L. VanLandingham, collector; on *Brickellia* sp.(?)

Reared to the pupal stage by Noel McFarland, on a substitute plant, *Eupatorium rugosum,* in Lawrence, Kansas.

Color transparencies by Carl W. Rettenmeyer.

Larva should be hanging from the branch rather than standing upright.

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2) A. Seitz (1940): *Macrolep. of the World* 6 (Text): 425,427,447.

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